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## Scientific Studies at Aldabra and Neighbouring Islands

D. R. Stoddart

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## Scientific studies at Aldabra and neighbouring islands

BY D. R. STODDART

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[Plate 1]

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## 1. INTRODUCTION

Aldabra and the neighbouring islands of Assumption, Astove and Cosmoledo, situated to the north of the Mozambique Channel (figure 1), were probably discovered by Portuguese navigators during the first decade of the sixteenth century. Nevertheless, they remained uninhabited for a further 400 years, permanent settlements being established first on Aldabra in 1888 and last on Assumption in 1908. The first hydrographic surveys were not carried out until 1878, and only after this time did scientific studies begin.

The four islands of the Aldabra group (figure 2) are distinguished primarily by being formed of coral reefs elevated 5 to 10 m above present sea-level. They are also situated in the driest sector of the southwest Indian Ocean, with a mean annual rainfall of less than 1000 mm. In flora and vegetation they differ markedly from the sand cays of sea-level atolls and from high islands, and because of their size, elevation and proximity to continental land the terrestrial biota is larger than is usual on coral atolls. The group lies 400 km north of Madagascar, and the terrestrial biota shows marked Malagasy and African affinities. These islands thus differ from the nearby islands of Farquhar and Providence, and the more distant islands of the Amirantes, Cargados Carajos and the Chagos Archipelago, which are all Recent detrital islands on sea-level coral reefs, with faunas and floras characteristic of those of open-ocean atolls. St Pierre, 430 km east of Aldabra, is also an elevated reef island, and the faunal and floral lists which are available (Dupont 1907; Vesey-FitzGerald 1942) show that before the exploitation of its guano reserves it closely resembled those of the Aldabra group. Because of its remoteness it is not normally included in the group, and it has not been studied in recent years. Of the islands in the Mozambique Channel, Europa most resembles Aldabra, and has been recently studied by a French expedition (Legendre 1966).

The islands of the Aldabra group are thus representative of a class of elevated limestone islands in the tropical seas. The characteristics of such islands are less well known than those of either coral atolls or volcanic islands (Fosberg 1961, 1966), largely because they are fewer in number and many have been severely disturbed during guano mining. In recent years only

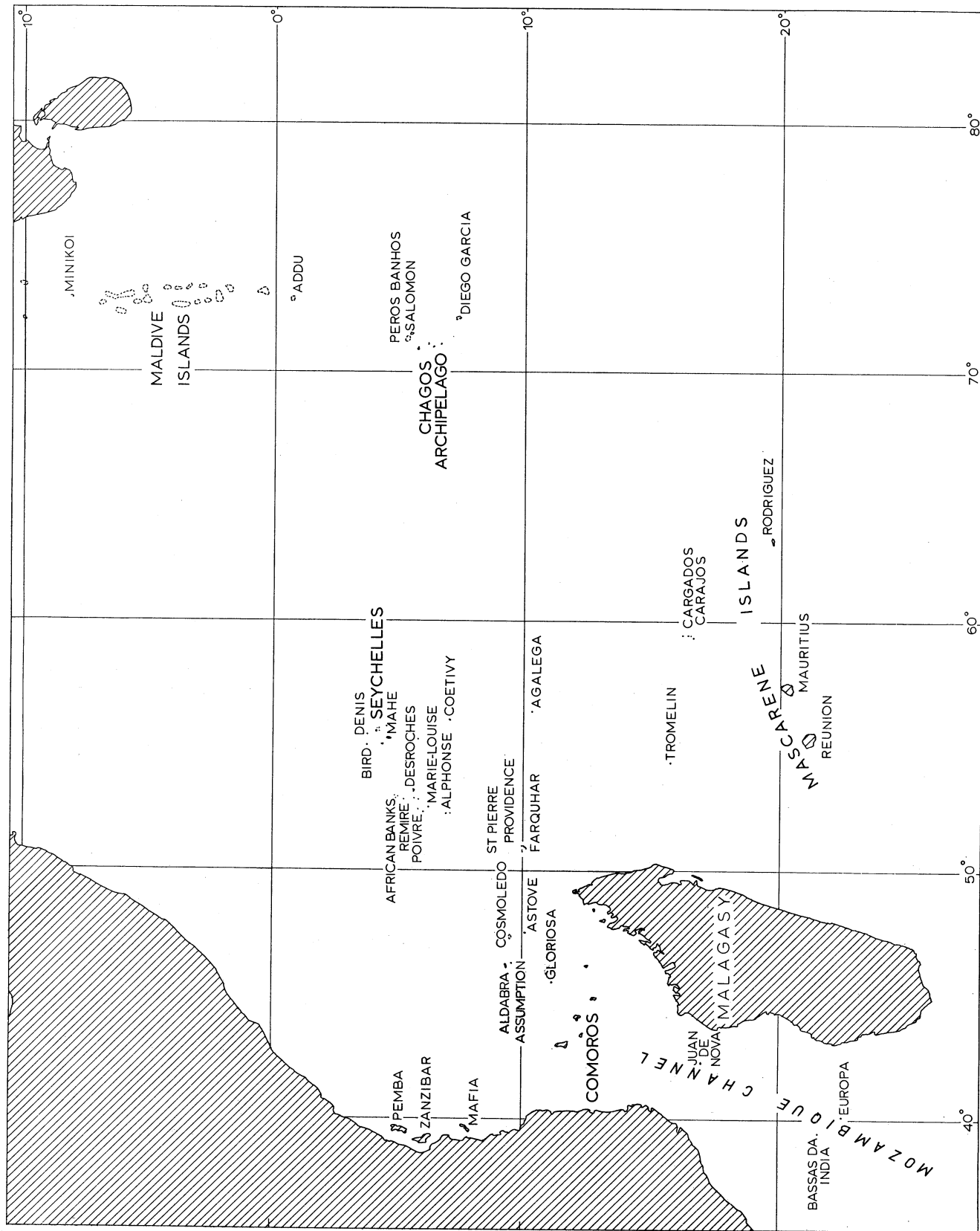


Figure 1. The western Indian Ocean, showing the location of Aldabra.

# SCIENTIFIC STUDIES AT ALDABRA

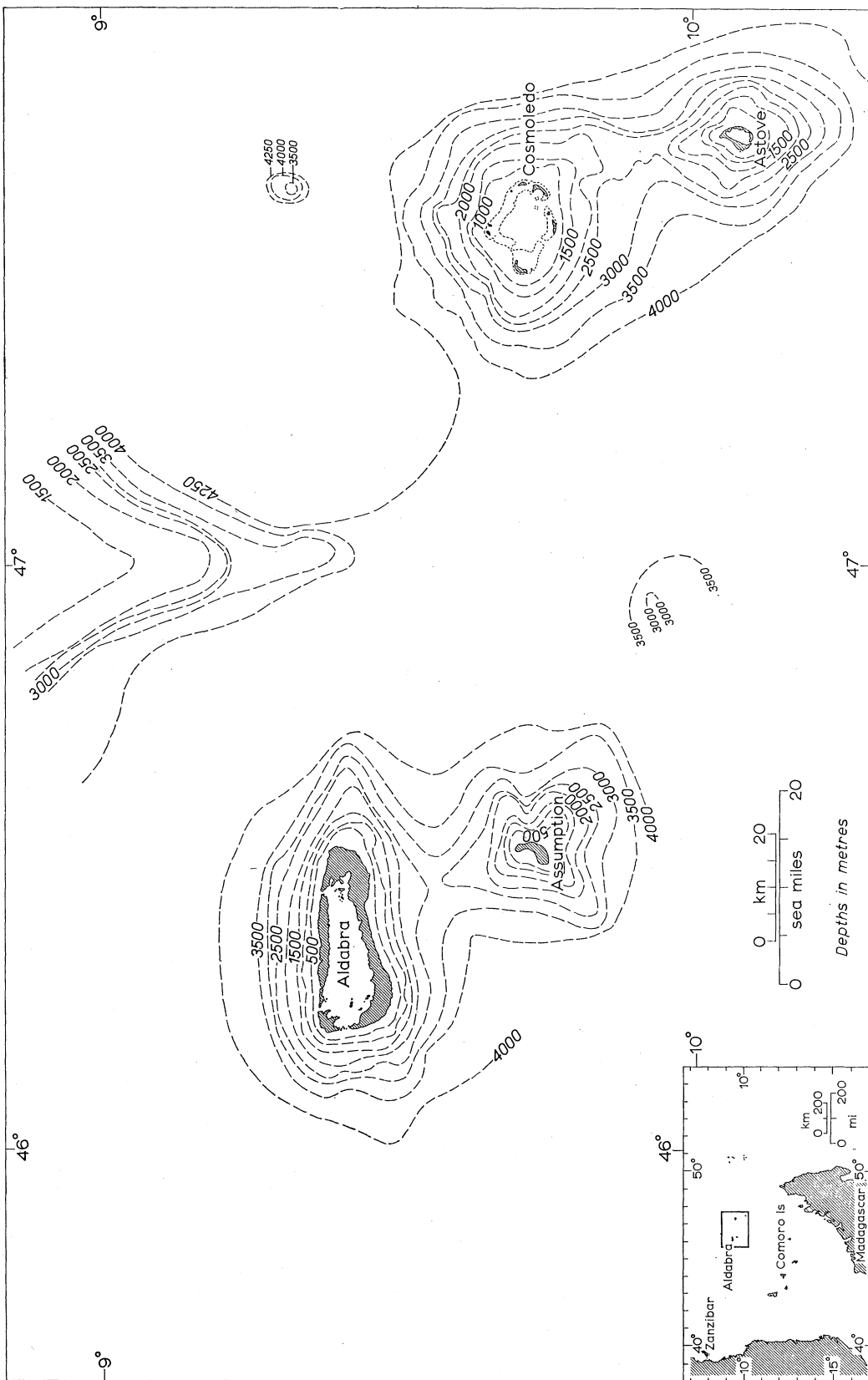


FIGURE 2. The Aldabra Group: Aldabra, Assumption, Astove and Cosmoledo.

Rennell Island in the Solomons has been studied in detail, but this is a humid rather than a semi-arid island as are those of the Aldabra group. The elucidation of the structure of the elevated-limestone island ecosystem at Aldabra is one of the aims of the Royal Society research programme.

This paper summarizes the progress of scientific work in the Aldabra group over the last hundred years, and outlines the scope and organization of the Royal Society Expedition to Aldabra which began in 1967. The prospect of military development on Aldabra, and the events which led to the launching of this Expedition, have been described elsewhere (Stoddart 1968*a, b*). A subsequent paper in this volume (p. 611) traces the progress of human settlement, its effects on the biota, and the history of conservation on the atoll.

Attention may also be drawn to the final paper in this volume (p. 631), on the place names of Aldabra, and to the standard names shown there on figure 1 and used throughout this series of papers.

## 2. SCIENTIFIC STUDIES BEFORE 1967

Much early information on Aldabra was frankly speculative, and once it appeared in the literature it was repeated by many authors. Horsburgh (1852, p. 176), for example, stated that 'from the appearance of these islands, water is perhaps plentiful, and also timber of sufficient size to be useful to any ship in distress for spars', and according to Pridham (1846, p. 307) 'water would appear to be plentiful'. Statements such as these were clearly not based on any real knowledge of the atoll. Occasional visits by passing ships have been recorded during the eighteenth and nineteenth centuries, and details are given by Stoddart (this volume, p. 611). The first sketch surveys of the group were those by Captain Richard Owen, H.M.S. *Leven*, at Astove in 1823 and at Aldabra in 1824, but these were very rudimentary (figure 3). The first detailed survey of Aldabra was that by Commander W. J. L. Wharton, H.M.S. *Fawn*, in 1878 (figure 4). Wharton also charted Assumption and Cosmoledo. Unfortunately he carried no naturalist, though his incidental comments on the natural history of Aldabra are of great interest (Wharton 1879, 1883).

Scientific knowledge of the group derives mainly from a series of visits between 1895 and 1908 by W. L. Abbott, A. Voeltzkow, M. J. Nicoll, R. P. Dupont, H. L. Thomasset, and J. C. F. Fryer. All of these visitors made large collections on Aldabra, particularly of plants, insects and birds. The main sources of information on Aldabra are the papers in the *Proceedings of the U.S. National Museum* reporting on Abbott's collections, the three large volumes resulting from Voeltzkow's expedition, and a long series of mainly systematic papers in the *Reports* of the Percy Sladen Trust Expeditions to the Indian Ocean in 1905 and 1908 (Gardiner 1907-36). The most useful general accounts of the ecology of Aldabra resulting from this work are those of Abbott (1893), Voeltzkow (1897, 1902*a, b*), Dupont (1907), and Fryer (1910*a, b*, 1911).

During the forty years following the Percy Sladen Trust Expedition there was little scientific activity in the Aldabra group, with the notable exception of L. D. E. F. Vesey-FitzGerald's (1940, 1941, 1942) studies of vegetation, land and sea birds in 1937. Ommanney (1952) wrote a popular account of Aldabra itself following the Mauritius-Seychelles Fisheries Survey in 1948. Several parties visited Aldabra during the 1950s, mainly to make collections of insects and of the marine fauna and to observe the birds, but the results of these appeared in scattered systematic papers and records of observations rather than in general ecological accounts. The geological and pedological work of B. H. Baker and C. J. Piggott on behalf of the Seychelles

Government in 1960–1 resulted in the first general studies of all the islands of the Aldabra group since those of Fryer in 1908, though necessarily based only on brief visits. Subsequently members of the Bristol Seychelles Expedition spent two extended periods on Aldabra in 1964 and 1965, and also called briefly at Astove, Assumption and Cosmoledo. Other scientific studies between 1878 and 1967 are listed in table 1.

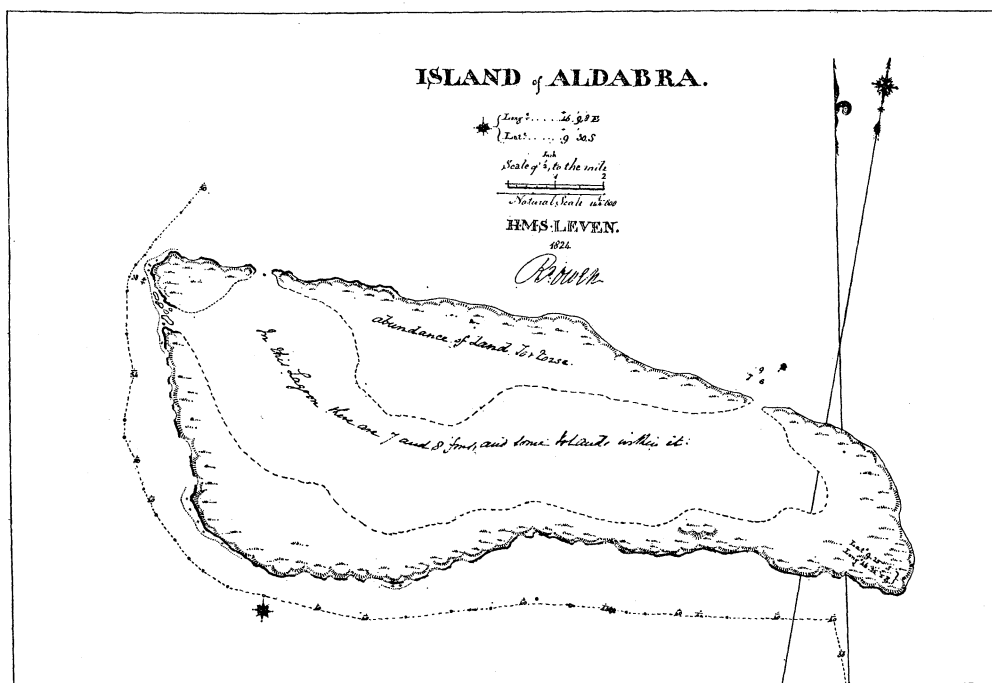


FIGURE 3. Chart of Aldabra by Richard Owen, H.M.S. *Leven*, 1824.

When it became known that plans for the military development of Aldabra were being considered, the Southern Zone Research Committee of the Royal Society supported the attachment of two scientists to an official expedition. C. A. Wright, of the British Museum (Natural History), and the writer visited Aldabra in September to October 1966, with the aim of making an assessment of the present ecological status of Aldabra and to consider the conservation measures which might be necessary if development took place. Summary accounts of the ecology of Aldabra were prepared following this reconnaissance (Stoddart (ed.) 1967; Stoddart & Wright 1967*a, b*; Wright 1967).

It was clear from this assessment that Aldabra itself is of considerable scientific importance. It is now the last home in the Old World of the Giant Land Tortoise *Geochelone gigantea*; the breeding ground of large numbers of sea birds, including the largest colony of Frigate birds, *Fregata* spp., in the Indian Ocean; and it has several distinct species and subspecies of land birds. Unlike most neighbouring islands, it has escaped massive interference by man, and it forms one of the last relatively undisturbed elevated limestone island ecosystems in the world. Though no observations could be made on other islands of the Aldabra group in 1966, a survey of the literature showed that all of them had undergone major human interference, either through guano mining or clearing for coconuts (Stoddart 1967). As a result, not only have these islands been invaded by alien plants and animals, but many species, especially the Giant Land Tortoise and the flightless birds, have become locally extinct since their discovery (Stoddart 1968*c*).



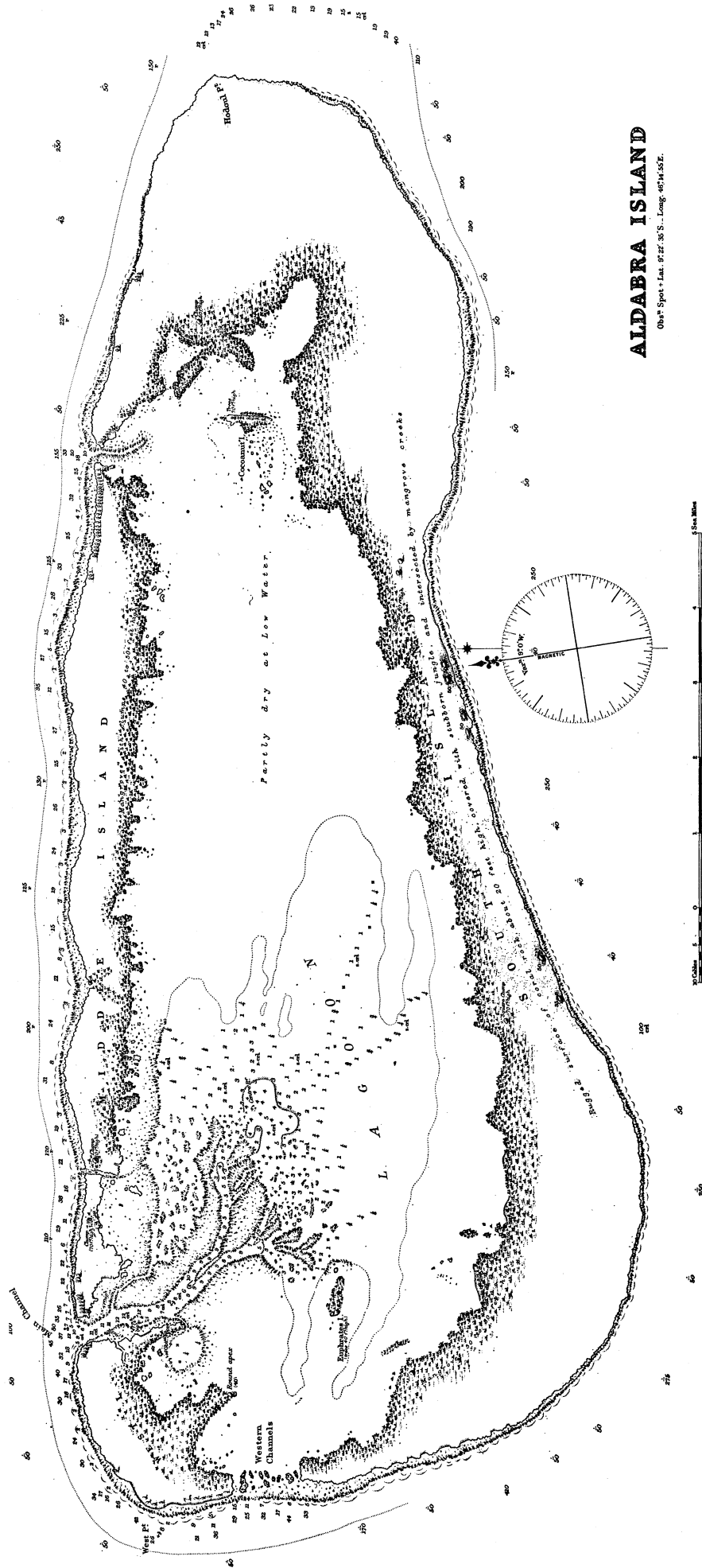


FIGURE 4. Chart of Aldabra by W. J. L. Wharton, H.M.S. *Fawn*, 1878.

TABLE I. SCIENTIFIC STUDIES IN THE ALDABRA GROUP, 1878–1967

date	investigator	field of study	Aldabra	Assump- tion	Astove	Cos- moledo	general publication
1878	H.M.S. <i>Fawn</i> , Cmdr W. J. L. Wharton	hydrographic survey	×	×	—	×	Wharton (1879, 1883)
1892 May	H.M.S. <i>Redbreast</i> , T. R. Griffith	general	×	—	—	—	Fairfield, Griffith & Abbott (1893)
1892 Sept. to Dec.	Dr W. L. Abbott	birds, insects, plants	×	×	—	—	Abbott (1893)
1895	S. C. E. Baty	agricultural development	×	—	×	×	Baty (1896), Bergne (1900)
1895	Mr Wilson	land Mollusca collection	×	—	—	—	Von Martens & Wiegmann (1898)
1895 Apr. to May	Dr A. Voeltzkow	geology, all groups	×	—	—	—	Voeltzkow (1897, 1899–1905, 1902 <i>b</i> )
1901	H. A'C. Bergne	general	×	×	×	×	Bergne (1901)
1903 Aug.–Nov.	F. R. Mortimer	birds	×	—	—	—	—
1904 Oct., Dec.							
1905	Anonymous	general	×	—	—	—	Anon. (1920)
1906	L. Ferrari	hydrographic notes	—	—	—	×	—
1906 May	<i>Valhalla</i> , Lord Crawford, M. J. Nicoll, E. G. B. Meade-Waldo	birds, insects	×	×	—	—	Nicoll (1906, 1908)
1906 Sept. to Nov.	R. P. Dupont	plants, insects, birds	×	×	×	×	Dupont (1907)
1907	H. P. Thomasset	insects	×	—	×	—	—
1907	A. d'Emmerez de Charmoy	general	×	—	—	—	—
1908 Sept. to 1909 Feb.	J. C. F. Fryer	geology, insects and other groups	×	×	×	×	Fryer (1910 <i>a, b</i> , 1911) Gardiner & Fryer (1908, 1909)
1910	R. P. Dupont	plants, insects, birds	—	×	×	—	Dupont (1916, 1924, 1929)
1916	W. Fox	plants	×	×	—	—	Hemsley (1919)
1937 Oct.	L. D. E. F. Vesey- FitzGerald	birds, vegetation	×	×	×	×	Vesey-FitzGerald (1940, 1941, 1942)
1948	Seychelles-Mauritius Fisheries Survey: J. F. G. Wheeler, F. D. Ommanney	commercial fisheries, turtles	×	—	—	—	Ommanney (1952), Wheeler & Ommanney (1953)
1953 Nov.	Italian Zoological Expedition: C. Prola, F. Palombelli, F. Prosperi, S. Nievo	insects	×	—	—	×	Prosperi (1956, 1957), Palombelli (1954)
1954 May	<i>Calypto</i> , Cmdr J.-Y. Cousteau, G. Cherbonnier	general, esp. under- water; Crustacea, birds	×	×	—	—	Cousteau (1959, 1963)
1954	J. L. B. Smith	fish	×	×	×	×	Smith (1955–8)
1956	W. Travis	underwater observations on <i>Trochus</i>	×	×	×	—	Travis (1959)
1956 Mar.	H. Legrand	Lepidoptera	×	×	—	×	Legrand (1965)
1957 Dec.	Yales Seychelles Expedition: A. J. Kohn, W. D. Hartman	general, birds	×	×	×	×	Hartman (1958)
1959	H.M.S. <i>Leopard</i>	birds	×	—	—	—	Boulton (1960)
1959	H. Legrand, M. Gerber	Lepidoptera	×	×	—	×	Legrand (1965)
1960 June	Spartan Air Services Ltd.	aerial photography	×	×	×	×	—
1960 Sept. to 1961 Jan.	B. H. Baker, C. J. Piggott	geology, soils, agriculture	×	×	×	×	Baker (1963), Piggott (1961 <i>a, b</i> , 1968)
1962 Jan.	H.M.S. <i>Owen</i> , Capt. G. P. D. Hall	hydrographic survey, birds	×	×	×	—	Morris (1963)
1964 Feb. to Mar.	R. E. Honegger, W. Noth	reptiles	×	×	×	×	Honegger (1966 <i>a, b</i> , 1967)
1964 Mar.	H.M.S. <i>Owen</i> , Cmdr D. W. Haslam	hydrographic survey, birds	×	—	—	×	Admiralty Chart 710 (1968), Bourne (1966)
1964 Nov. to Dec.	Bristol Seychelles Expedition: M. J. Penny, C. M. Penny, R. Gaymer, R. Blackman, P. G. Dawson	birds, tortoises	×	×	—	×	Blackman (1966), Gaymer (1967, 1968), Gaymer & Penny (1966)
1965 Oct. to Nov.	R. Gaymer	birds, tortoises	×	×	—	×	Gaymer (1966, 1967)
1966 Sept.	D. R. Stoddart, C. A. Wright	geomorphology, land ecology	×	—	—	—	Stoddart, ed. (1967), Stoddart & Wright (1967 <i>a, b</i> ), Wright (1967)
1966 Feb. to Mar.	J. F. G. Lionnet, H. H. Beamish, H. Hirth	turtles, insects	×	×	—	—	F.A.O. (1968), Beamish (1967, 1970)
1967 Aug. to Sept.	H.M.S. <i>Vidal</i> , Capt C. R. K. Roe	hydrographic survey	×	×	—	—	Admiralty Chart 710 (1968)
1967 Oct.	M. V. Manihine, M. D. Gwynne, D. Wood, I. S. C. Parker	plants, birds	×	×	×	×	Parker (1970), Gwynne & Wood (1969)
1967–8	Mrs R. M. Veervers- Carter, Miss T. Ridgway	plants	—	—	×	—	Fosberg & Renvoize (1970 <i>c</i> )



## 3. THE ROYAL SOCIETY EXPEDITION TO ALDABRA

Following the 1966 reconnaissance, and in view of the apparently imminent military development of Aldabra, the Royal Society proceeded to mount an expedition to the atoll to make a survey of the ecology, particularly of terrestrial communities threatened with disturbance. The initial aims of the expedition were thus concerned with an inventory of the biota, especially of the terrestrial fauna and flora, and with recording the numbers and distribution of selected species. Because of the shortage of time and the lack of detailed information on Aldabra it was at that stage neither possible nor desirable to plan more detailed studies. The expedition as originally conceived was to extend over the dry season of 1967 (August to December) and the wet season of 1968 (January to March). This period was divided into three phases, and was subsequently extended after April 1968. Table 2 lists the expedition personnel and fields of study from the beginning of the project in August 1967 to the end of phase VI in February 1969.

TABLE 2. MEMBERS OF THE ROYAL SOCIETY EXPEDITION TO ALDABRA, PHASES I TO VI

name	institution at time of visit	phase	field
Barnes, W. J.	—	VI	diving research assistant
Bayne, Dr C. J.	Marine Laboratory, University College of North Wales	V (part)	marine molluscan ecology
Bellamy, Dr D.	Department of Botany, University of Durham	VI (part)	reef ecology; phytosociology of terrestrial vegetation
Benson, C. W.	Department of Zoology, University of Cambridge	I, III	land birds
Boyd, Dr J. M.	Nature Conservancy, Edinburgh	I	conservation
Brander, K. M.	Marine Laboratory, University College of North Wales	V	littoral and sublittoral invertebrate ecology, especially Polychaeta
Cogan, B. H.	Department of Entomology, British Museum (Nat. Hist.)	III	insects, esp. Diptera
Diamond, A. W.	Culterty Field Station, University of Aberdeen	I, II, III	sea bird ecology
Drew, E. A.	Gatty Marine Station, University of St Andrews	VI	marine algae
Farrow, Dr G. E.	Department of Geology, University of Hull	V	growth and ecology of marine bivalve molluscs
Fehlmann, Dr H. A.	Oceanographic Sorting Center, Smithsonian Institution, U.S.A.	I	fish collection
Fosberg, Dr F. R.	Smithsonian Institution, U.S.A.	III	terrestrial flora and vegetation
Frazier, J. G.	Department of Zoology, University of Oxford	III, IV	tortoise behaviour; marine turtles
Gamble, J. C.	Marine Laboratory, University College of North Wales	IV, V (part)	littoral and sublittoral invertebrate ecology
Graham, J. C.	—	III	tortoise studies assistant
Grubb, P.	Zoological Society of London	I, II, III	tortoise population, growth and ecology
Hughes, R.	Marine Laboratory, University College of North Wales	IV	ecology of <i>Nerita</i>
Humphreys, W. F.	Marine Laboratory, University College of North Wales	V	littoral and sublittoral invertebrate ecology, especially Echinodermata
Hutson, A. M.	Department of Entomology, British Museum (Nat. Hist.)	III	insects, esp. Diptera
Jones, D. J.	Department of Botany, University of Durham	VI	reef communities
Kenyon, L.	—	VI	underwater photography
Lowery, Dr R. S.	Department of Botany and Zoology, Sir John Cass College	IV	blood parasites
Lythgoe, Dr J. N.	Institute of Ophthalmology London	VI	reef and pelagic fish populations

TABLE 2 (*cont.*)

name	institution at time of visit	phase	field
McKenzie, Dr K. G.	Department of Zoology, British Museum (Nat. Hist.)	III	freshwater ecology; Entomostraca
McLeod, A. A. Q. R.	Marine Laboratory, University College of North Wales	V	littoral and sublittoral invertebrate ecology, especially Crustacea
Macnae, Dr W.	Department of Zoology, University of the Witwatersrand, South Africa	III	mangrove ecology
Passmore, N. I.	Department of Zoology, University of the Witwatersrand, South Africa	III	mangrove ecology
Peake, J. F.	Department of Zoology, British Museum (Nat. Hist.)	I	land mollusca
Penny, M. J.	Department of Zoology, University of Bristol	I, II	wading birds
Potts, Dr G. W.	The Marine Laboratory, Plymouth	V	fish ethology
Price, J. H.	Department of Botany, British Museum (Nat. Hist.)	I	marine algae
Renvoize, S. A.	Royal Botanic Gardens, Kew	III	terrestrial flora
Rhynne, C. F.	Smithsonian Institution, U.S.A.	I	marine algae
Shaffer, Dr J. C.	Smithsonian Institution, U.S.A.	III	insects, esp. Lepidoptera
Stickley, Sgt H. C.	640 Signal Troop, Blandford	I, II, III	communications
Stoddart, Dr D. R.	Department of Geography, University of Cambridge	I, V (part) reconn.	geomorphology, terrestrial flora
Taylor, Dr J. D.	Department of Zoology, British Museum (Nat. Hist.)	I, II	intertidal ecology, esp. marine mollusca
Walker, Sgt J. E.	640 Signal Troop, Blandford	I, II, III	communications
Whitton, Dr B. A.	Department of Botany, University of Durham	VI	marine and freshwater algae
Wright, Dr C. A.	Department of Zoology, British Museum (Nat. Hist.)	reconn.	freshwater mollusca
Yeates, Cpl A. G.	Royal Air Force, Uxbridge	III	medical

The advance party of phase I arrived at Aldabra on H.M.S. *Vidal* in mid-August 1967, and was joined by seven further members from Mombasa at the end of the month. Phase I was planned to take to Aldabra a large and diverse party of scientists, including both marine and terrestrial specialists, to provide a broadly based assessment of the ecological state of the atoll from which further plans could be made. Phase II, from October to December 1967, led by Dr J. D. Taylor, comprised four scientists, studying the tortoises, the land birds and sea birds, and marine communities, all of which would be liable to disturbance by any development. Phase III, January to March 1968, initially planned to be a small one, was considerably increased in scale towards the end of 1967 when the decision to build an airfield seemed imminent, for it then seemed likely that the wet season of 1968 would be the last such season for work to be carried out under undisturbed conditions. Under the leadership of Dr K. G. McKenzie, the party finally consisted of eleven scientists concerned with terrestrial ecology. Unfortunately very little rain fell during this phase, and biological activity was consequently inhibited.

The Government's decision not to proceed with the Aldabra development was reached before phase III left for the atoll. The Royal Society had already discussed the need for a small research station on the atoll, and because of the need for continuing studies and also because of the large quantities of equipment on the atoll, it was decided to continue the expedition after

March 1968 until a research station could begin to operate. The first three phases of the expedition had necessarily been planned under the prospect of military development, with the aim of recording as much information and as quickly as possible. After phase III it was decided to reduce the scale of activities considerably, and to change the emphasis, at least for some months, from work on terrestrial ecology, which is relatively vulnerable to disturbance by scientists, to marine ecology, to which much less attention had so far been given.

Phase IV, from April to July 1968, under the leadership of Dr R. Lowery, continued some of the tortoise work and concentrated on studies of marine invertebrates. Phase V, from August to November 1968, led by Dr G. W. Potts, was devoted to shallow-water marine ecology, with studies both of invertebrates and of fish. Phase VI, from December 1968 to February 1969, led by Dr D. J. Bellamy, concentrated on an integrated programme of S.C.U.B.A. studies on reef communities in deeper water, and also included work on terrestrial vegetation. During phase V, in September 1968, a visit was made to Aldabra by a party comprising the Chairman of the Aldabra Research Committee, Professor T. S. Westoll, F.R.S., the Director of the Nature Conservancy, Dr M. E. D. Poore, and the leader of the Expedition, Dr D. R. Stoddart.

During phase I the Expedition established its headquarters at the Settlement on West Island, and through the kindness of the Lessee, Mr H. Savy, was given the use of the Guest House, Hospital and other buildings. Diesel generators were installed, a meteorological station was set up, and a radio station manned by Sgt J. Walker transmitted daily to London and Mauritius. Sgt H. Stickley was in charge of the expedition's small flotilla of boats and engines. A network of major camps was established round the atoll (figure 5): Middle Camp (Passe Houareau), Cinq Cases, Takamaka, and Dune Jean-Louis were occupied fairly continuously throughout the expedition. Additional camps were maintained from time to time at Anse Grande Poche (Main Channel), Passe Gionnet, Anse Cèdres, Dune d'Messe, Ile Esprit and Anse Mais, and emergency dumps of food and water were maintained at camp sites and at a number of additional localities, particularly at Point Hodoul, Anse Takamaka, and Point aux Vaqua. Because movement with large loads is only possible along the lagoon at spring tides, the problems in maintaining and supplying these camps were considerable. The expedition employed a number of Seychellois labourers, and was aided from time to time by members of the Lessee's labour force.

During the work on Aldabra the opportunity was taken, when possible, to land parties at other islands in the group. In this way it has been possible to assemble data on the ecological status of Astove, Assumption and Cosmoledo, and to make additional collections. Table 3 records the visits made to these islands during the Royal Society expedition. The results of these visits will be published separately: on Assumption by Stoddart, Benson & Peake (1970) and Fosberg & Renvoize (1970*a*); on Cosmoledo by Bayne *et al.* (1970*a*), Fosberg & Renvoize (1970*b*) and Benson (1969, 1970*a*); and on Astove by Bayne *et al.* (1970*b*), Fosberg & Renvoize (1970*c*), and Benson (1970*b*).

#### 4. STATUS OF ALDABRA RESEARCH IN 1969

Though few general accounts of the ecology of Aldabra have appeared since Fryer's (1911), much information on this atoll, and to a lesser extent on Astove, Assumption and Cosmoledo, is contained in the systematic reports on collections made during the early expeditions of

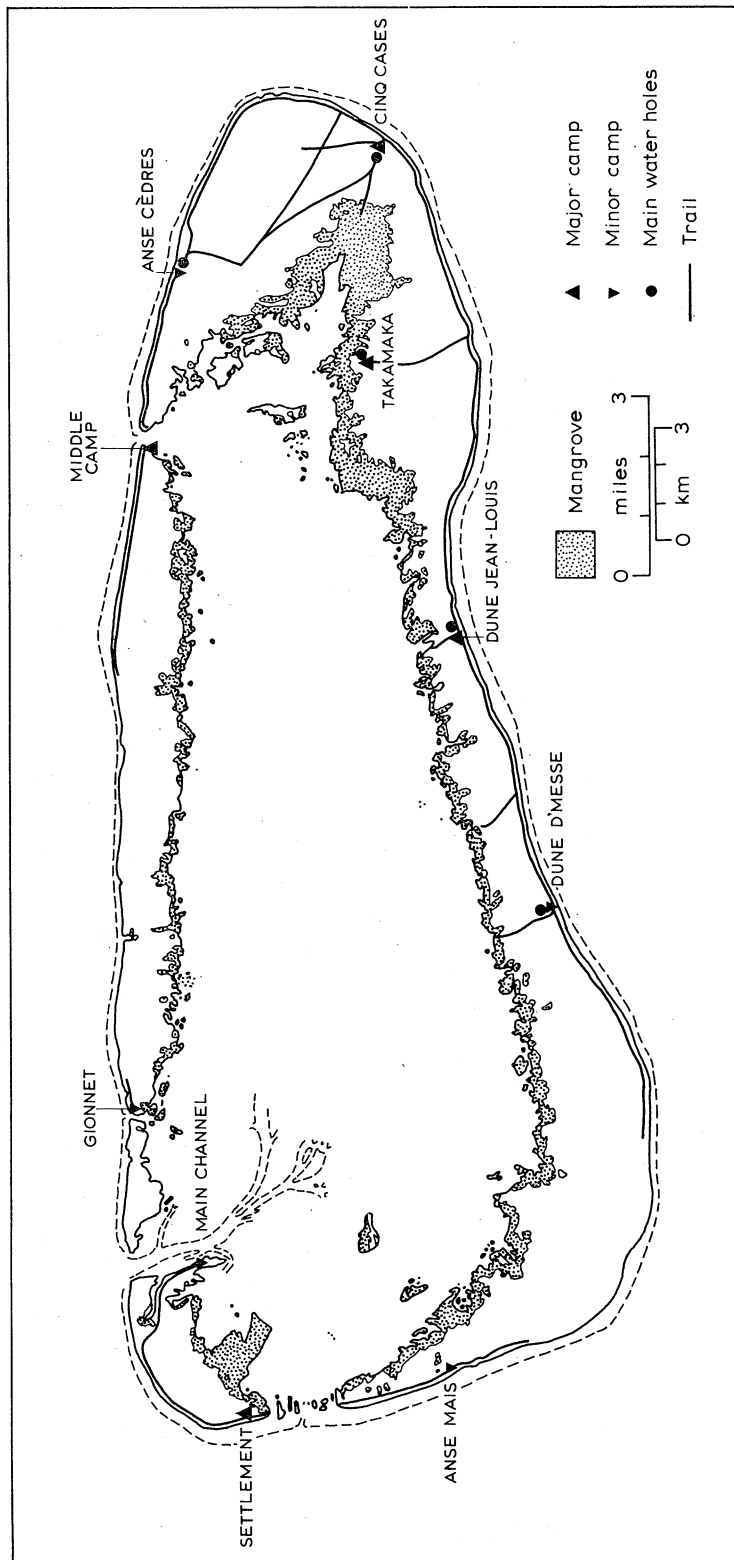


Figure 5. Camps occupied by the Royal Society Expedition, main waterholes, and well-marked tracks at Aldabra.

Abbott, Voeltzkow, Dupont and Fryer. These records have not been brought together since the summary report by Voeltzkow (1902*b*), and many now require revision, particularly in view of the recent resumption of collecting. Recent large collections, before those of the present Expedition, have been made by the *Calypso* expedition in 1954, by J. L. B. Smith in 1954, and by H. Legrand in 1956 and 1959. This section keys the very large systematic literature on the fauna and flora of Aldabra, though many of the items noted may contain only one or two species from this and the neighbouring islands. Plans are in hand to abstract this literature and to make the data available on punched cards as part of the Aldabra data-recording programme.

TABLE 3. STUDIES ON NEIGHBOURING ISLANDS DURING THE ALDABRA EXPEDITION

	Assumption 15–16 Sept.	Astove	Cosmoledo
1967	C. W. Benson J. M. Boyd J. F. Peake J. H. Price D. R. Stoddart E. N. Wright†		
1968	31 July J. Frazier J. C. Gamble R. Hughes R. S. Lowery	5 Mar. C. W. Benson B. H. Cogan A. W. Diamond F. R. Fosberg J. Frazier A. Graham P. Grubb A. M. Hutson K. G. McKenzie S. A. Renvoize	6 Mar. C. W. Benson B. H. Cogan A. W. Diamond F. R. Fosberg J. Frazier A. Graham P. Grubb A. M. Hutson K. G. McKenzie A. S. Renvoize
		15 Sept. C. J. Bayne J. C. Gamble M. E. D. Poore‡ D. R. Stoddart T. S. Westoll‡	14 Sept. C. J. Bayne J. C. Gamble M. E. D. Poore‡ D. R. Stoddart T. S. Westoll‡

† Ministry of Agriculture, Fisheries and Food, attached to Ministry of Defence party.

‡ Royal Society Aldabra Research Committee.

#### (a) Habitats

Comprehensive schemes of habitat classification, for both terrestrial and marine communities, are in preparation by J. F. Peake and J. D. Taylor, to provide a recording system for all collections made on Aldabra. It is appropriate to mention here, by way of introduction to the reports which follow, certain broad categories, developed from those described by Fryer (1911) and Vesey-FitzGerald (1942), and shown in figure 6. Fryer distinguished two main categories of limestone surface on the atoll, for which he used the local terms *champignon* and *platin*. *Champignon* is used for a wide variety of pinnacled, fretted, potholed and scoriaceous limestone surfaces, *platin* for smoother, pavement-like surfaces. While many more categories of surface forms can be distinguished (Stoddart *et al.*, this volume, p. 31), to the extent that in some places the distinction between *champignon* and *platin* is difficult to define, the terms are nevertheless useful as first approximations. While they are primarily used to describe surface form, they have also been used to describe vegetation types, the *champignon* being characteristically covered with a scrub 2 to 5 m tall of *Pemphis acidula*, *Mystroxydon aethiopicum* and other species,



6



8



9



10



11



12



13



14



FIGURE 6. Coastal champignon with low open scrub, near Dune d'Messe, South Island.

FIGURE 8. Smooth slabby surface and tall open scrub in the platin of South Island, south of Anse Cèdres.

FIGURE 9. Clifed coast on the seaward coast of Ile Polymnie, close to Main Channel.

FIGURE 10. Ramp-like cliffs with a turfied perched beach on the seaward coast of South Island, near Cinq Cases.

FIGURE 11. High dunes with *Tournefortia* scrub at Dune Jean-Louis, South Island.

FIGURE 12. Mangrove woodland (*Avicennia* and *Rhizophora*) in the lagoon at Ile Esprit.

FIGURES 13, 14. Tortoises *Geochelone gigantea* at freshwater pools in the South Island platin, near Croix Blanc.

and the platin with a much more open mixed scrub or woodland. A further important distinction lies in the fact that in the champignon surface water is rare, and the groundwater in solution holes is generally saline or brackish, whereas in the platin, with a flat-lying dimpled surface, pools of fresh to brackish water are common. Champignon, which near the coast is devoid of vegetation (figure 6, plate 1), covers most of the main islands. In figure 7 a distinction is made between low champignon, generally less than 2 m above the water table and covered with a dense and almost impenetrable scrub; high champignon, with a less dissected surface and lower, more open vegetation on the surface of a ridge round the periphery of the atoll, reaching 7 to 8 m above sea-level; and unvegetated champignon, in exposed coastal areas. Platin, which covers about one-quarter of the total land area of 155 km<sup>2</sup>, is only extensively developed at the eastern end of South Island (figure 8, plate 1), and more patchily on West Island. The term *pavé* has been introduced (Stoddart *et al.*, this volume, p. 31) for massive limestone surfaces showing very little dissection, and resembling platin, found on the surface of the 8 m ridge, forming part of the high champignon shown in figure 7.

Round most of the atoll the seaward coast is cliffed and undercut (figure 9, plate 1), though on the exposed south coast the cliff is more ramplike and is surmounted by a perched beach covered with a mosaic of *Sporobolus virginicus* and *Sclerodactylon macrostachyum*. The beach in places develops into high dunes covered with grasses and littoral shrubs (figures 10 and 11, plate 1). The lagoon shore, though lower, is also cliffed and generally delicately notched at intertidal levels; but much of it is fronted by mangrove communities (figure 12, plate 1).

The main concentrations of the Giant Land Tortoise are found on the platin at the east end of South Island (figures 13 and 14, plate 1) and at the high dunes of the south coast. The main colonies of breeding sea birds (*Fregata* spp. and *Sula sula*) are found in mangroves at the eastern end of Middle Island.

#### (b) *Geology and geomorphology*

The first full account of the geomorphology of Aldabra was that of Fryer (1911), who correctly deduced that Aldabra is an elevated atoll, and who made the distinction between champignon and platin. Further data on geology and geomorphology are given by Voeltzkow (1902*a*), Baker (1963), and Stoddart & Wright (1967*b*), as well as in the present report (Stoddart *et al.*, this volume, p. 31).

#### (c) *Vegetation and flora*

Following the compilation of a first list by Schinz (1897) and the addition of records by Baker (1894), Christensen (1912) and Hemsley (1916, 1917), the flora of Aldabra was worked up by Hemsley (1919), based on the collections of Abbott, Voeltzkow, Dupont, Fryer and Fox. Brief notes on vegetation are given by these earlier workers and in early general accounts of the atoll, but the first specific account of the vegetation types is that of Vesey-FitzGerald (1942). With the large collections made during the present expedition and with the availability of aerial photographs, these accounts require much revision. Comprehensive revision of the flora is being undertaken by S. A. Renvoize and F. R. Fosberg, and the vegetation has been studied by Fosberg (this volume, p. 215), Macnae (p. 237) and Whitton (p. 249).

#### (d) *Marine fauna and flora*

Until the *Calypso* expedition and the visit by J. L. B. Smith in 1954, no specialist collections of marine biota had been made on Aldabra. The records in the literature are of scattered species only, and give little impression of the composition of the marine fauna and flora and none of its

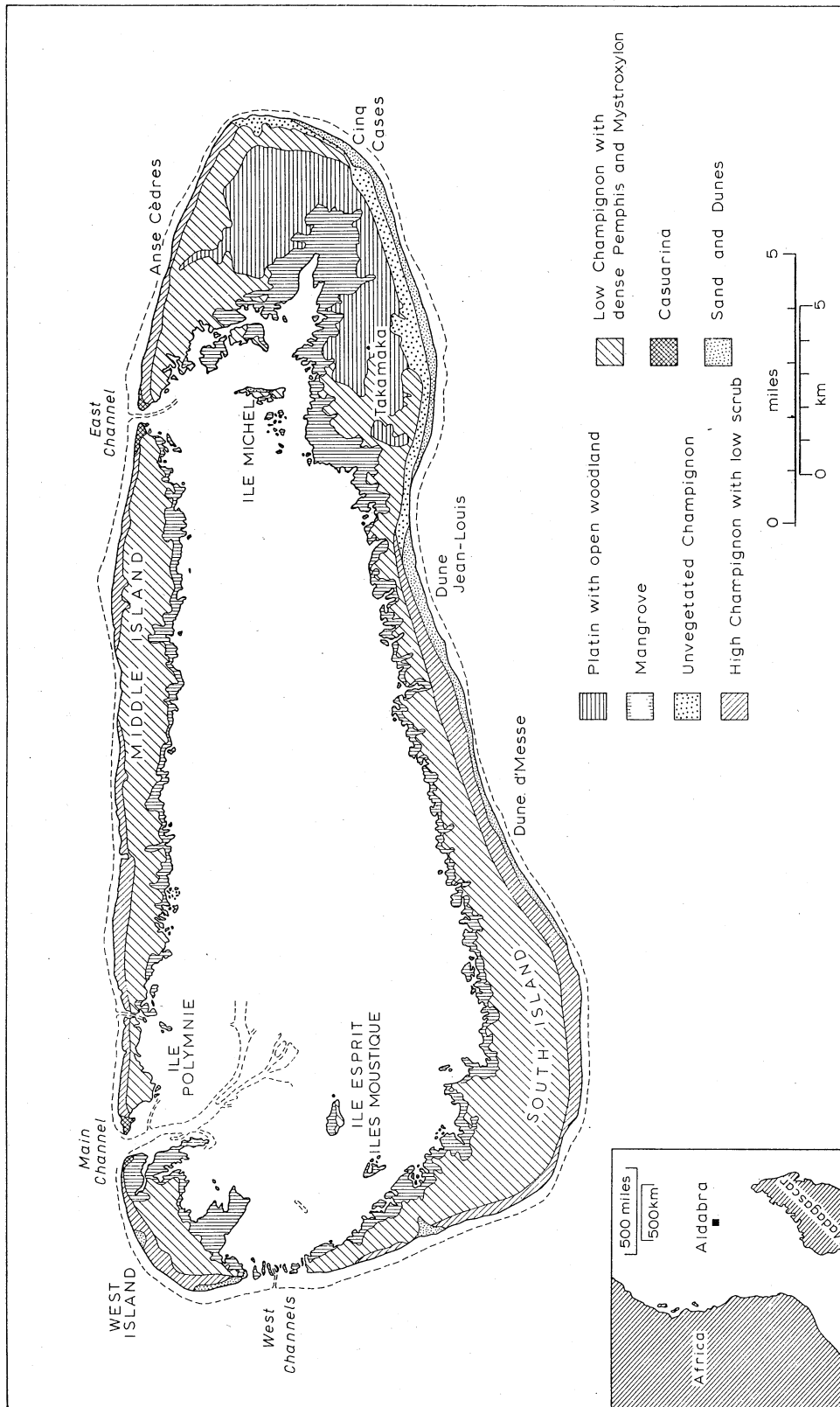


FIGURE 7. Main terrestrial habitats at Aldabra Atoll.



ecology. Table 4 lists the literature so far published on the marine biota of Aldabra. Large collections have been made during the present expedition, especially of the marine algae by J. H. Price and C. F. Rhyne (the only previous records were those of Weber-van Bosse (1914)), of fish by H. A. Fehlmann, and of many invertebrate groups, especially molluscs, crustaceans, echinoderms, scleractinian corals, and polychaetes. Faunal lists for these groups are in preparation.

TABLE 4. STUDIES OF THE MARINE FAUNA OF ALDABRA

Porifera	Lévi (1961)
Coelenterata	Döderlein (1902), Matthai (1914, 1928), Tixier-Durivault (1966)
Echinodermata	Ludwig (1899)
Arthropoda	
Crustacea	
Cirripedia	Newman (1967), Southward (1967)
Decapoda	Borradaile (1910, 1917), Guinot (1964), Lenz (1905), Rathbun (1894)
Stomatopoda	Lenz (1905)
Mollusca	
Pelecypoda	Thiele (1902)
Gastropoda	Eliot (1910), Melvill (1909), Thiele (1902)
Amphineura	Thiele (1902)
Vertebrata	
Pisces	Arnoult, Bauchot-Boutin & Roux-Estève (1958), Jatzow & Lenz (1899), Regan (1912), Smith (1955 <i>a, b, c</i> , 1955-8, 1958)

TABLE 5. STUDIES OF THE TERRESTRIAL FAUNA OF ALDABRA  
OTHER THAN INSECTS AND BIRDS

Nemertea	Ehlers (1897)
Mollusca	Connolly (1925), Von Martens & Wiegmann (1898)
Arthropoda	
Crustacea	Budde-Lund (1912), Müller (1898)
Arachnida	Hirst (1913)
Chordata	
Reptilia	Boettger (1913), Boulenger (1909, 1911), Gaymer (1968), Günther (1877), Honegger (no date, 1966 <i>b</i> ), Hooker <i>et al.</i> (1875), Loveridge & Williams (1954), Rothschild (1915, 1928), Sauzier (1893), Schacht (1902), Siebenrock (1904), Stejneger (1893), Voeltzkow (1896)
Mammalia	Lorenz-Liburnau (1899), Miller (1902), True (1893)

*(e) Terrestrial fauna*

With the exception of insects and birds, the literature on the terrestrial fauna of Aldabra is small. Most attention has been given to the Giant Land Tortoise, though few papers report original field observations; the most important are Rothschild's general review (1915) and Gaymer's (1968) report on the work of the Bristol Seychelles Expedition. Information on marine turtles has been given by Spurs (1892), Hornell (1927), Wheeler (1953), Parsons (1962), Honegger (1967) and Hirth (F.A.O. 1968). Table 5 lists the literature on terrestrial fauna other than the insects and birds.

Considerable attention has been given to the insects and birds of Aldabra by visiting collectors. Since, as Cogan, Hutson & Shaffer (this volume, p. 315) show, the number of species per genus and per family among the insects is low, the entomological records are scattered in more than eighty papers, most of which result from the work of J. C. F. Fryer during the Percy Sladen Trust

TABLE 6. STUDIES ON THE INSECT FAUNA OF THE ALDABRA GROUP

order	papers	Aldabra	Assumption	Astove	Cosmoledo
Thysanura and Collembola	Carpenter (1916)	×	—	—	—
Orthoptera	Bolivar (1912)	×	×	×	×
	Bolivar (1924)	×	×	×	×
	De Saussure (1897)	×	—	—	—
	Linell (1897)	×	—	—	—
Dermaptera	Burr (1910)	×	×	—	×
Isoptera	Holmgren (1910)	×	—	—	—
	Wasmann (1897)	×	—	—	—
Embioptera	Enderlein (1910)	×	—	—	—
Anoplura	Scott (1914)	×	—	—	—
Odonata	Blackman & Pinhey (1967)	×	×	—	×
	Calvert (1898)	×	—	—	—
	Campion (1913)	×	×	—	×
	Linell (1897)	×	—	—	—
Hemiptera	Austen (1910)	×	—	×	—
	Bergroth, in Voeltzkow (1902 <i>b</i> )	×	—	—	—
	Distant (1913)	×	×	×	×
	Distant (1917)	×	×	×	—
	Green (1907)	×	—	×	—
	Green & Laing (1921)	×	×	×	—
	Hutchinson (1927)	×	—	×	—
	Linell (1897)	×	—	—	—
Neuroptera	Mamet (1943)	×	—	×	—
	Esben-Petersen (1927)	×	—	—	—
Lepidoptera	Needham (1913)	×	—	—	—
	Aurivillius (1909)	×	—	—	—
	Berio (1956)	×	—	—	×
	Berio (1959)	×	—	—	—
	Berio (1962)	×	—	—	—
	Bernardi (1968)	×	—	—	—
	Bigot (1962)	×	—	—	—
	Bourgogne (1963)	×	—	—	×
	Carcasson (1964)	×	—	—	×
	Diakonoff (1969)	×	—	—	—
	Fletcher (1910 <i>a</i> )	×	×	—	—
	Fletcher (1910 <i>b</i> )	×	—	—	—
	Fryer (1912)	×	×	×	×
	Hampson (1908)	×	×	—	—
	Herbulot (1962)	×	—	—	—
	Holland (1895)	×	—	—	—
	Karsch (1900)	×	—	—	—
	Legrand (1965)	×	—	—	×
	Meyrick (1911)	×	—	—	—
	Toulgoët (1965)	×	—	—	—
Viette (1958)	×	—	—	—	
Coleoptera	Aurivillius (1922)	×	×	—	—
	Bernhauer (1922)	×	—	—	—
	Champion (1914)	×	×	×	×
	Champion (1917)	×	—	—	—
	Fairmaire (1896)	×	—	—	—
	Flautiaux (1922)	×	—	—	—
	Gebien (1922)	×	×	×	×
	Grouvelle (1913)	×	—	—	—
	Grouvelle (1918)	×	—	—	—
	Jordan (1914)	×	—	—	—



TABLE 6 (*cont.*)

order	papers	Aldabra	Assumption	Astove	Cosmoledo
Coleoptera	Kerremans (1914)	x	—	—	—
	Kolbe (1902)	x	—	—	—
	Linell (1897)	x	—	—	—
	Maulik (1917)	x	—	—	—
	Maulik (1931)	x	—	—	—
	Régimbart (1900)	x	—	—	—
	Schenkling (1922)	x	—	x	x
	Scott (1912)	x	x	x	x
	Scott (1913)	x	—	—	—
	Scott (1922 <i>a</i> )	x	—	—	—
	Scott (1922 <i>b</i> )	x	—	—	—
	Scott (1926 <i>a</i> )	x	x	—	x
	Scott (1926 <i>b</i> )	x	—	—	—
Sicard (1912)	x	—	—	x	
Hymenoptera	Burr (1910)	—	—	x	—
	Cockerell (1912)	x	x	—	x
	Forel (1897)	x	—	—	—
	Forel (1912)	x	—	—	—
	Friese (1902)	x	—	—	—
	Meade-Waldo (1912)	x	—	—	—
	Morley (1912)	—	x	—	x
	Turner (1911)	x	x	x	x
Diptera	Bezzi (1923)	x	x	—	—
	Eaton (1913)	x	—	—	—
	Edwards (1912)	x	—	—	—
	Hermitte (1931)	x	—	—	—
	Kertész (1912)	x	—	—	—
	Lamb (1912)	—	—	x	—
	Lamb (1914)	x	x	—	—
	Lamb (1922)	x	x	—	x
	Linell (1897)	x	—	—	—
	Matthew (1932)	x	x	—	—
	Mattingly & Brown (1955)	x	—	—	x
	Scott (1914)	x	x	—	—
	Stein (1910)	x	—	—	—
Theobald (1912)	x	—	—	—	

Expedition. These are keyed in table 6 for all the islands of the Aldabra group. Because of the attention given by earlier collectors to the insects, and because of the larger size and greater diversity of Aldabra itself, more than 360 species had been recorded by 1967, compared with not more than 100 on the other coral islands of the western Indian Ocean and with more than 2000 on the Seychelles. Recent collecting has probably trebled the number of species known from Aldabra. Scott (1933) has contributed a general review of western Indian Ocean insect faunas.

The birds, particularly the land birds, have been studied in detail by previous workers (Bendire 1894; Benson 1963; Berlepsch 1899; Boulton 1960; Bourne 1966; Dawson 1966; Dupont 1907; Gaymer 1967; Günther 1879; Meade-Waldo 1908; Morris 1963; Nicoll 1906, 1908; Penny 1965; Ridgway 1893, 1894 *a, b*, 1895; Sclater 1871; Vesey-FitzGerald 1940, 1941; Watson, Zusi & Storer 1963), and were comprehensively reviewed by Benson (1967) at the start of the Royal Society Expedition. Work by C. W. Benson, M. J. Penny and A. W. Diamond is reported in this volume.

## 5. RESULTS OF THE ROYAL SOCIETY EXPEDITION

The Discussion Meeting at the Royal Society on 13 to 14 March 1969 was held to summarize research carried out during the expedition and to provide a base-line of information for the work of the research station about to be built. Because the expedition is still continuing, the Discussion was largely confined to the work of phases I to III, and hence to the terrestrial ecology. The work of the marine parties will be discussed at a later stage.

Several papers, including those on geomorphology by Stoddart, Taylor, Fosberg and Farrow, on climate by Farrow, and on tides by Farrow & Brander, can be considered as background papers for the ensuing discussion. Two papers deal with littoral marine communities, Taylor on intertidal zonation patterns and Price on marine algae. The terrestrial flora and vegetation are covered by papers on the flora by Renvoize, on the freshwater and terrestrial algae by Whitton, on the vegetation by Fosberg, and on the mangroves by Macnae. Work on the freshwater Crustacea and Mollusca is covered by McKenzie and by Wright; on insects by Cogan, Hutson & Shaffer; on tortoises by Grubb; on bats by Hill; on marine turtles by Frazier; on land birds by Benson & Penny; and on sea birds by Diamond. Peake considers faunal and floral distribution patterns on islands of the western Indian Ocean.

Many of the results of the expedition will not become available for some years, or can only be stated at present in a preliminary manner, particularly where taxonomic problems arise. In some cases collections may also be required not only from the adjacent islands of the Aldabra group but also from Madagascar and the African coastlands. But the process of inventory on Aldabra itself is now reasonably complete, and attention can be turned more to the structure and functioning of the Aldabra ecosystems rather than simply to their components.

Plans have been made to complete the basic information available to workers at the Research Station by the provision of a network of topographic benchmarks round the atoll, linked to a tidal datum; of a vegetation map drawn from air photographs and keyed by ground survey; and of geological and hydrogeological surveys. The research programme of the Station will include provision for the establishment of reference quadrats throughout the atoll and of regular monitoring of tortoise, turtle and bird populations.

Research at Aldabra began under the direction of the Southern Zone Research Committee of the Royal Society, under the chairmanship of Professor C. F. A. Pantin. During 1967 research was organized by the Aldabra Subcommittee of the Southern Zone Research Committee, under Sir Maurice Yonge. In December 1967 the Royal Society established the Aldabra Research Committee, with Professor T. S. Westoll as chairman, to coordinate and extend research activities.

The work on Aldabra has been made possible by the support of the Royal Society, and in particular of Professor C. F. A. Pantin and Sir Ashley Miles, and of the Southern Zone Research Committee and the Aldabra Research Committee. It has also been encouraged by the successive Commissioners of the British Indian Ocean Territory, Sir Hugh Norman-Walker and Sir Bruce Greatbatch, and the Administrator, Mr John Todd, all of whom, together with the Chairman of the Aldabra Research Committee, Professor T. S. Westoll, have been able to visit the expedition on the atoll.

The Royal Society Expedition began in close liaison with several official parties. We thank particularly Rear-Admiral G. S. Ritchie and Capt C. R. K. Roe, H.M.S. *Vidal*, for their aid,

and Wg-Cdr P. A. S. Thompson and Wg-Cdr P. H. Pryor for their help and companionship in the field. We particularly appreciate the assistance given to the expedition by Sgt H. Stickley, Sgt J. E. Walker and Cpl A. G. Yeates, on secondment from the Ministry of Defence during the first three phases of the Expedition. We are grateful to Lord Shackleton, then Minister of Defence for the Royal Air Force, for his assistance in planning the expedition. We also thank Mr C. E. Loveridge and his colleagues of the Ministry of Public Buildings and Works, and Mr A. Bosworth and his colleagues in the British Broadcasting Corporation, for their help in the field.

The task of moving personnel to and from Aldabra, and keeping the expedition supplied, has been made easier by the cooperation of the Director, East African Marine Fisheries Research Organization, Mr Basil Bell, and by Capt M. Williams and Capt T. Phipps, of M.F.R.V. *Manihine*. On Aldabra our work would have been impossible without the cooperation and aid of the Lessee, Mr Harry Savy, his managers and labourers, and we are grateful to Mr Harry Savy, Mr Michael Savy and Mr Daniel Labworth for their aid.

For the loan of unpublished diaries and other papers concerning the visits to Aldabra of Mr H. A'C. Bergne in 1900 and Sir John Fryer in 1908–9, which are of great value, and for permission to quote from these documents, we thank Mr J. A'C. Bergne and Lady Joan Fryer.

Figures 2, 3 and 4 are reproduced from original British Admiralty Surveys and Charts with the sanction of H.M.S.O. and the Hydrographer of the Navy.

Finally, I thank Mr M. Young, Mr R. Coe, and other members of the staff of the Department of Geography, Cambridge, for the work they have carried out in cartography, photography etc. in connexion with this project; and the staff at the Royal Society, Mr G. E. Hemmen, Mr D. J. H. Griffin, Mr L. Mole and Miss C. Johnson, through whose efforts the expedition was kept supplied in the field.

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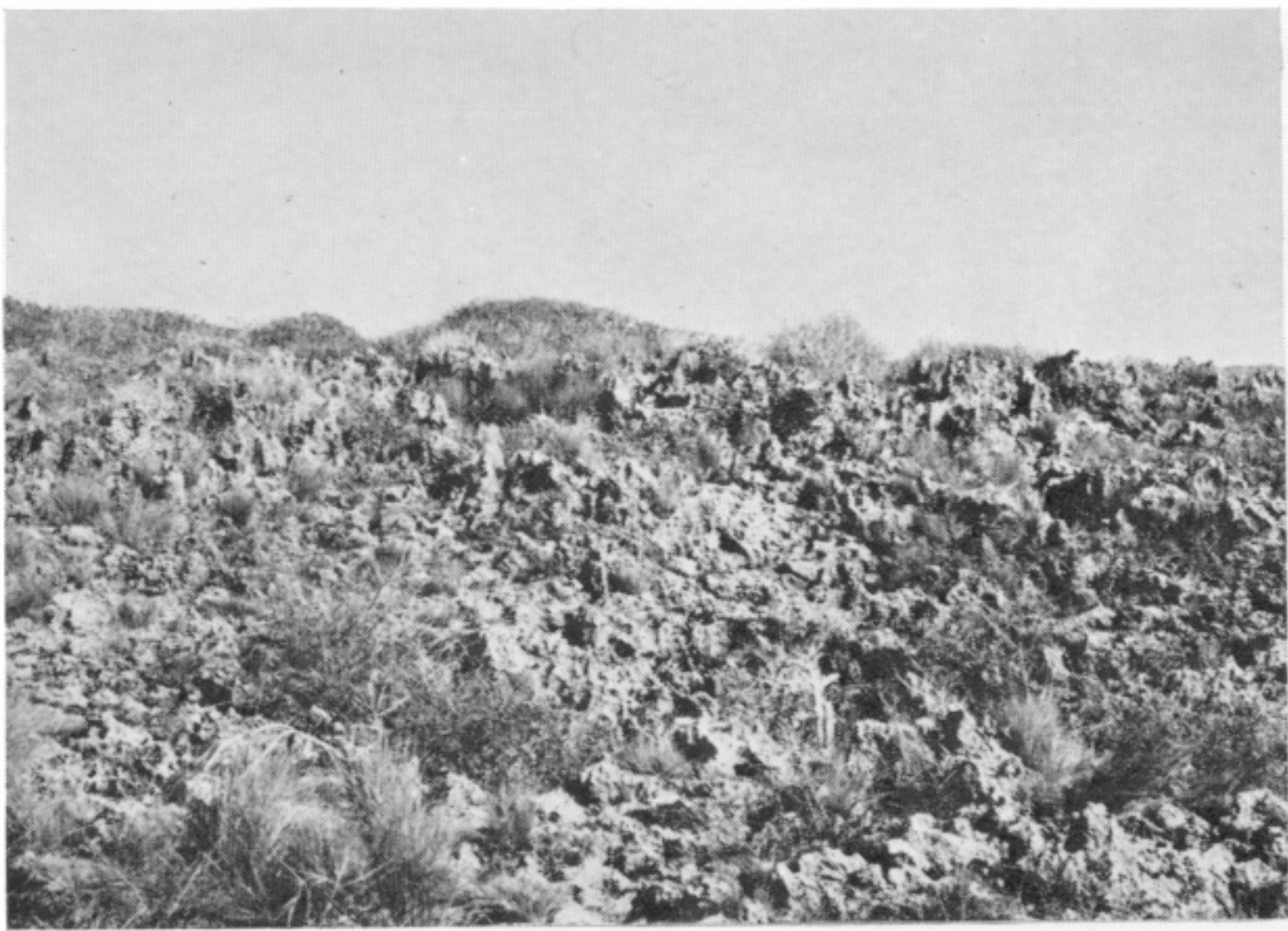
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FIGURE 6. Coastal champignon with low open scrub, near Dune d'Messe, South Island.

FIGURE 8. Smooth slabby surface and tall open scrub in the platin of South Island, south of Anse Cèdres.

FIGURE 9. Clifed coast on the seaward coast of Ile Polymnie, close to Main Channel.

FIGURE 10. Ramp-like cliffs with a turfed perched beach on the seaward coast of South Island, near Cinq Cases.

FIGURE 11. High dunes with *Tournefortia* scrub at Dune Jean-Louis, South Island.

FIGURE 12. Mangrove woodland (*Avicennia* and *Rhizophora*) in the lagoon at Ile Esprit.

FIGURES 13, 14. Tortoises *Geochelone gigantea* at freshwater pools in the South Island platin, near Croix Blanc.

(Facing p. 17)